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RESEARCH

DESIGN & DEVELOPMENT

TOOL & SPLICE FOR

TELEPHONE CABLE WF-16 ( ) / (U)

FINAL REPORT

March 1961 to January 1963

Contract No. DA36-039 SC87226
File No. 39578-PM-61-91-91 (6609)

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I. PURPOSE

The purpose of this report is to describe and present the design approaches, design work, and functional characteristics of the Splicing Tool TL-674 ( ) / g (Burndy Corporation Catalog Number MR8-77) and Splice (Burndy Corporation Catalog Number P2S22). Both tool and splice were developed under Contract No. DA36-039 SC-87226 for the purpose of making rapid field splices on Telephone Cable WF-16 ( ) / (U), in accordance with Signal Corps Technical Requirements SCL-4272.

II. ABSTRACT

The basic concept of this contract was the design and development of a Splicing Tool and Splice for Telephone Cable WF-16 ( ) / (U). The Splice and Tool must join two parallel pairs of Telephone Cable WF-16 ( ) / (U) in a single actuation of the tool. Further the tool is to be of relatively small size and incorporate a mechanism to prepare the cable ends for crimping. This mechanism was to cut the cable to length, strip the insulation to a given dimension, and split the pair of conductors for insertion into the splice. The completed splice was to have a relatively high tensile strength and be moisture resistant.

In the early design stages it became apparent that crimping the entire splice (4 cables) in one actuation of the tool would be impractical. Basically, this involved crimping the wire and insulation of each of the four-two wire conductors at the same time; however, the requirements of tensile strength, moisture resistance, together with the need for a relatively small sized tool, made this approach completely undesirable. In discussions with USASRDL it was pointed out that crimping the entire splice in one operation would be outside the capabilities of a practical hand tool. During these meetings, the consideration of going to a hand tool which crimped one side

of the splice at a time was also taken up. In the final analysis, it was felt that such a tool would be undesirable due to the increased time required to make an installation. The approach finally selected was to crimp both ends of a splice, joining two parallel pairs of WF-16 ( ) / (U) cable simultaneously. Actual force measurements revealed that the hand force required to complete the crimp in one actuation of the tool is high. However, it should be noted that the tool can be operated by an average male adult without great difficulty.

As specified in Contract No. DA36-039 SC87226, prototype models of a splicing tool and sleeves were developed and submitted for testing and approval by the Signal Corps in July, 1962. Based on the results of lab testing and joint agreements arrived at by Burndy and the Signal Corps, certain aspects of the tool and splice performance were evaluated which led to refinements such that the remaining tools (4) and splices (3200) to be delivered per the contract included these modifications. Basically, the areas of refinement centered around: 1) the terminated splice properties both mechanical and electrical 2) improvement of the guide mechanism which locates the prepared cable in the splice prior to crimping and 3) the specifying of more suitable metal finish requirements, to be compatible with exposure, at extended periods to high humidity and salt spray conditions.

The above mentioned areas were thoroughly covered and definite design changes instituted, such that the 4 tools and 3200 splices recently submitted to the Signal Corps, (January, 1963) met the requirements of Spec SCL-4272. Basically, the crimp joint strength and moisture resistance characteristics were improved and found satisfactory; more applicable metal finishes were specified on critical components; the wire guides were redesigned and improved, thus facilitating the job of getting the WF-16 ( ) / (U) cable properly inserted into the splicing sleeve.

III. REPORTS

1st Monthly	18 May	1961 to 16 June	1961
2nd "	16 June	1961 to 17 July	1961
3rd "	17 July	1961 to 17 August	1961
1st Quarterly Report	18 May	1961 to 15 Sept.	1961
4th Monthly	18 August	1961 to 17 Sept.	1961
5th "	18 Sept.	1961 to 17 Oct.	1961
6th "	18 Oct.	1961 to 21 Nov.	1961
2nd Quarterly Report	16 Sept.	1961 to 15 Dec.	1961
7th Monthly	22 Nov.	1961 to 22 Dec.	1961
8th "	22 Dec.	1961 to 22 Jan.	1962
3rd Quarterly Report	16 Dec.	1961 to 15 Feb.	1962
9th Monthly	22 Jan.	1962 to 15 Feb.	1962
10th "	15 Feb.	1962 to 15 March	1962
11th "	15 March	1962 to 15 April	1962
12th "	15 April	1962 to 15 May	1962
13th "	15 May	1962 to 15 June	1962
14th "	15 June	1962 to 15 July	1962
4th Quarterly Report	15 Feb.	1962 to 15 July	1962
16th Monthly	15 July	1962 to 15 Sept.	1962
17th "	15 August	1962 to 15 Sept.	1962
18th "	15 Sept.	1962 to 15 Oct.	1962
19th "	15 Oct.	1962 to 15 Nov.	1962
20th "	15 Nov.	1962 to 15 Dec.	1962

Equipment Compliance Report - 9 July 1962
Equipment Compliance Report - 17 Jan. 1963

IV. CONFERENCES

2 June	1961	Burndy Corporation
29 July	1961	Fort Monmouth
26 Sept.	1961	Burndy Corporation
14 Dec.	1961	Burndy Corporation
20 Feb.	1962	Burndy Corporation
24 April	1962	Burndy Corporation
28 June	1962	Fort Monmouth
20 Sept.	1962	Burndy Corporation
2 Nov.	1962	Fort Monmouth

V. FACTUAL DATA

A. Development of Crimping Splice

In the initial stages of this program, certain design parameters as to size and material characteristics were defined, and as such served to govern our splice concept.

From a purely overall dimensional standpoint, Technical Requirement SCL4272 specified a splice length not to exceed 1 1/2 inches with a major diameter of completed cable splice no greater than 1/4 inch. With these dimensional limits as a guide, consideration was then given to arrive at the necessary splice length and diameter which would permit the obtaining of the functional requirements of a completed splice to be consistent with SCL4272.

The functional requirements as noted in SCL4272 were used to a arrive at the splice insulating material selected, as well as the material for the metal ferrules, both outer and inner, which make up the splice assembly. The outer metal ferrules are crimped to seal off the ends of the splice such that the insulation resistance requirement of 10 megohms measured under 1 foot of water, after immersion for 24 hours is complied with. Upon evaluating various materials, soft copper was selected for the outer ferrules due to its forming characteristics, which permitted compression of the splice nylon sleeve to the cable insulation in order to obtain good water sealing. The requirement that the completed splice

be a stable electrical joint influenced the use of tin plated, soft copper inner ferrules, which, when crimped, maintained good electrical conductance and also complied with the necessary joint tensile strength agreed to by Burndy and the Signal Corps (Ref. Monthly Report dated 17 July 1961 to 17 August 1961).

The results of the above evaluation, tests and retests led to the existing splice design supplied to the Signal Corps. Problems were encountered with water sealing of the crimp and were resolved by a modification to the splice, which added more nylon material in the area being sealed under the outer copper ferrules. The results of this redesign were very significant, as indicated in the Equipment Compliance Report submitted with the 4 tools and 3200 splices (see APPENDIX). In summation, the average insulation resistance prior to the redesign was 1 megohm while the average of the redesigned splice was 13 megohms.

The electrical characteristics of the crimped splice were acceptable and did not present any design difficulty. The joint tensile strength average was improved somewhat on the final tools and splices submitted to the Signal Corps, primarily due to modifications of the tool covered in the following discussion.

B. Splicing Tool

The physical appearance and overall dimensions of the tool were specified in SCL-4272, and as such served to establish the parameters guiding and limiting its design. The general descrip-

tion of the tools construction and performance requirements listed in SCL4272, Section 3.7 was considered in the development of the tool. As noted, the tool had to be rugged, while maintaining a minimum weight; its size was to be kept at a minimum to be consistent with its weight; it was to have integral accommodations for cutting and stripping cable and should operate easily without noticeable binding or other malfunctioning.

The design approaches taken to accomplish the above can be broken down into three areas: 1) the basic crimp tool which provides the force to perform the splice crimp, 2) the crimp dies which perform the splice crimp, and 3) the integral mechanism required to strip and cut off the Telephone Cable WF-16 ( ) / (U).

Evaluating the basic tool in light of the physical requirements, we selected a tool of a heat treated aluminum alloy body, for weight purposes. The internal actuating members of the tool are of alloy steel, employing a handle forging, which through a linkage arrangement, drives the lower crimping die and delivers the necessary compression force. The force delivered to the crimp dies is the result of the tools mechanical advantage and provides the force necessary to actuate the crimping dies and make a functional splice joint.

The actual crimping dies were developed through experimentation using various groove configurations for both the water seal and wire crimp portions of the completed splice. The crimp

groove shape for the wire splice compresses both inner copper ferrules to the Telephone Cable. The actual die set dimensions, depth of indent, etc., were arrived at such that maximum joint tension strength could be attained, while remaining compatible, in terms of hand force required to complete the splice termination. This compression of the inner ferrules to cable is accomplished such that the dielectric insulating material of the splice is not damaged.

The outer ferrule water sealing crimp differs from the wire crimp in that it is accomplished by means of interlocking finger type indentors. Again, the actual crimp dimensions were established by experimentation and testing, in order that the desired level of insulation resistance, after water immersion, can be attained.

The two types of crimps, water seal and wire compression were then put into a common die for continued testing. Slight modifications were made to the die due to twisting of the splice during crimping; basically, the water seal crimp was slightly modified to eliminate this condition. The interlocking teeth were also fabricated as separate components and were pressed into and pinned to the proper die half, in order that blade replacement, in case of damage, could be made as well as to facilitate die manufacturing.

Once the crimp was fully developed, the other areas of SCL,272 were considered; namely, that of providing a means of properly locating the splice in the crimp die; holding the stripped cables in the tool and guiding the cables into the pre-positioned splice. Concepts were analyzed, sketched, developed, and finalized and prototype samples were fabricated. After discussing the concepts and demonstrating the prototypes to the Signal Corps, approval was given and work started to further develop the prototype components to accomplish the above.

The results of our efforts led to the design of: 1) special wire holders located on each face of the tool body, 2) spring loaded wire guides mounted to the upper and lower die halves, and 3) a special holding and positioning device attached to the lower die half. All of the above devices were de-bugged and finalized prior to the final submission of the 4 tools and 3200 splices.

VI. CONCLUSION

In the development of the splicing sleeve certain problems presented themselves, which required evaluations leading to modifications of the basic sleeve. These modifications were discussed with the pertinent Signal Corps' representatives and later instituted into the splice design.

The problems encountered were in the areas of: 1) water sealing and 2) wire entry into the splice prior to crimping. A redesign of the splice entry holes for the Telephone Cable, enabled the crimped splice to meet the wet insulation requirements and facilitated the job of getting the stripped cable into the splice. In effect, more nylon insulating material was added to the splice in the area undergoing sealing. The cable hole entries were also opened up and made to accept the stripped wire more readily. These two improvements, when adopted into the splice design, enabled compliance with SCL4272, as previously stated. The 3200 splices supplied as part of the contract commitment included the abcve modifications. The actual test data can be found in the APPENDIX of this report in the Compliance Report dated 17 January 1963.

In arriving at the finalized tool design, as submitted along with the 3200 splices, certain previously known deficiencies were corrected as the result of meetings and discussions between our

Engineering staff and the Signal Corps' representatives. The first tool submission made in July 1962, revealed the need for improvement in the following areas: 1) wire guides 2) wire stripper mechanism 3) wire holders 4) splice positioner.

Through intensive design effort, the areas noted above were evaluated and the inherent difficulties rectified. The results of the Signal Corps' testing program for the prototype tool submitted in July 1962, revealed a definite need for a more positive wire guide mechanism. Strands of the stripped cable were being snagged and doubled back onto the cable insulation, effecting the ultimate joint tensile strength and wet insulation resistance properties. Since the WF-16 ( ) / (U) cable is made up of 7 strands, the loss of one strand from the crimp will lower the strength of the joint by 1/7. This may render the joint incapable of meeting the minimum tensile requirement of 72 lbs. To insure the crimping of each wire strand, the wire guides were redesigned so as to capture the wire insulation before the bared strands enter the splice entry. With the insulation supported between spring loaded guides, designed so as to be in line with the splice entry, the mere continued pushing of the cable into the tool will properly insert it into the splice. To further assure proper wire entry, the splice itself was also improved as mentioned previously.

The problem which had to be resolved with the wire stripper mechanism was one of assuring that all of the stripped insulation was allowed to fall out of the stripper mechanism. Basically, bits of wire insulation were being wedged between the stripper and cut-off blades of the mechanism, leading to eventual failure of the stripper unit. To eliminate this problem, a special deflector type spacer was located between the stripper and cut-off blades, such that any insulation tending to wedge itself between the blades would simply be deflected, allowing it to then be flipped out of the tool. With the spacer in place no further problem was encountered in this area.

In the testing of the wire holders it was found that their position relative to the crimp location should be improved to allow proper guiding of the cable into the splice. This was accomplished by putting the holders more nearly in line with the wire guides. The other improvement required was that the cable be more securely held in the holders. This was done by providing a better gripping surface through the addition of serrations to the insulation holding surfaces.

VII. OVERALL CONCLUSIONS

In evaluating the design efforts of this contract, in light of accomplishments, the following represents our conclusions.

A splice for the joining of 2 cables, (each cable consisting of 2 parallel conductors), has been developed and, when used in conjunction with the crimp tool developed under this same contract, complies with the requirements of SCL4272.

Both tool and splice has been developed for use in climatic conditions, to facilitate the task of splicing Telephone Cable WF-16 ( ) / (U), in an expeditious manner to achieve both a reliable and dependable splice joint. Drawings of splice, tool, and all related components have been supplied to the Signal Corps. All reports required by the contract have been provided and with the submission of this final report the development work under this contract is completed.

VIII. RECOMMENDATIONS

During the development of this tool and splice, the question arose as to whether it was practical to simultaneously crimp the entire splice and the two cables being joined in one operation. It must be realized that this entails making eight (8) crimps in one actuation of the tool--one crimp each on the four (4) conductors being joined and one crimp each on the insulation of those conductors. Discussion and consideration of this question took place (ref. 2nd Quarterly Report) and it was the decision of the Signal Corps' representatives that the development should focus on a tool to crimp the entire splice in one operation. Some of the factors influencing this feeling were:

a. A previous Service Crimping Tool crimped on a Telephone Cable splice in one operation. (This splice, however, accommodated a different cable and only one wire was inserted in each end of the splice.)

b. There may be more chance for operator error in a tool requiring two (2) crimp operations.

c. The time required for a completed splice may be greater in a two (2) crimp tool.

d. A "one crimp operation" tool represented a higher development goal and the question--can it be done--would remain unanswered unless tried.

The "one crimp operation" tool and splice has been developed and furnished under this contract. Their manufacture and usage is not considered impractical. In looking back, it is felt that the decision to design for the "one crimp operation" was a good decision. Much more knowledge has been gained from the development contract than if the decision had been otherwise. As will be shown later in this recommendation, almost all of the knowledge gained and designs developed are applicable in considering a "two crimp operation" tool. It is clear, now that the experience of the development has been gained, that the following factors are associated with a "one crimp operation" tool:

1. The hand force to close the tool and complete the crimp is high, approaching the maximum practical hand force to be expected of a male adult on a repetitive operation. Our development experience indicates that the "one crimp operation" tool, as developed, is near the lowest force obtainable in keeping with performance and size requirements.

2. The tool is more complex and costly. The crimp die configurations and wire guide components are doubled. Dimensional and assembly tolerances on these parts must be held closer than normal due to the affect of one crimp upon the other, one guide upon the other, etc. It was found necessary to incorporate a splice loading slide into the tool due to the inaccessibility of the double sided crimp die for loading the splice directly into the die, this further increases complexity and cost.

3. The tool is larger (width and thickness of head) and heavier than a tool need be if one end of the splice is crimped per operation.

4. The increased complexity renders the tool more subject to damage from rough handling and usage, exposure, etc.

In reviewing our development efforts and the resultant tool and splice, it is seen that much of the effort and resultant design could be applicable to a tool which crimps one end of the splice at a time. It is felt that the following components of the existing design could be utilized with no change whatsoever.

a. The splice itself.

b. The shear, strip, and split mechanism.

c. The basic tool (frame, handle and linkages).

d. The crimp die configuration (but applied to a single end crimp).

e. The wire guide components (but only one set needed).

Thus, a tool to crimp the splice in two operations could be achieved with a minimum amount of effort. The resultant tool would have no loading slide, half the crimp die and wire guide components, and require less hand force to operate. The operational steps for the tool would be:

1. Shear, strip and split both WF-16 ( ) / (U) cables and insert them into the wire holders on the tool.

2. Insert the splice into the crimp die groove, (simply pushing the splice in from the back of the tool), and close the tool part way to hold the splice in place.

3. Insert one of the cables through the wire guide and into the splice, close the tool to complete the crimp, open the tool and remove splice.

4. Insert the uncrimped end of the splice into the crimp die as in Step #2 above.

5. Complete the crimp on the remaining cable as in Step #3 above.

It is recommended that the advantages and disadvantages of the two approaches ("one crimp operation" vs. "two crimp operation") be carefully evaluated and considered by the Signal Corps. It is felt that the Signal Corps, as purchaser and user of the equipment, should be the evaluating and decision making authority. Tools to either approach can be manufactured and can be made to conform to the requirements of the specification. The tool, as developed, represents the more ambitious approach and its good level of success throughout the many tests performed has been rewarding. There may, however, be enough merit to the alternate approach to warrant that it again be considered.

BURNDY CORPORATION
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EQUIPMENT COMPLIANCE REPORT
(CONTRACT #DA36-039 SC-87226)
SIGNAL CORPS TOOL AND SPLICE
(MR8-77, P2S22)

JULY 9, 1962

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PURPOSE

The purpose of this report is to describe, present and evaluate the performance results of the Signal Corps Tool & Splice, developed under Contract No. DA36-039 SC-87226, and covered by technical requirement no. SCL4272.

QUALIFYING STATEMENT

All conclusions and statements presented in this report are based on the test data compiled herein, as well as on BURNDY experience in crimp type tooling anc connectors. Certain tests specified in SCL4272 were not performed because of lack of equipment, or because of insufficient definition of test. This applies to the bounce test, vibration test, and the rain test and the dust test. Certain other tests were not performed because of limitation of time. This applies to the humidity test and the salt spray test. However, the basic tool, catalog number MR8, has passed the Salt Spray test previously (Ref. First Monthly Report, 15 September 1961). The entire testing program employed approximately 300 splices, and 3 crimp tool variations; however, the test data represented in the body of this report was compiled with an exact duplicate of the prototype tool and splices submitted per contract number DA36-039 SC-87226.

DESCRIPTION OF ITEMS

Crimp Tool (MR8-77)

The BURNDY MR8-77 HYTOOL has an open head made of heat treated aluminum alloy, approximately 10½ inches long, 3 inches wide. The completely assembled tool weighs approximately 1 and 3/4 pounds, and requires a butting force of approximately 60 pounds to release the ratchet and actuate the wire stripping mechanism. (Refer to Appendix for complete operational description.) This tool is a self contained wire strip, wire support, wire guide, splice locator, splice crimping, full butting ratchet controlled type crimp tool (see Figure 1).

Splice (P2S22)

The P2S22 is made up of an outer nylon outer body with two OFHC fully annealed, tin plated copper inner ferrules and two outer, fully annealed OFHC tin plated copper sleeves. The complete splice assembly is approximately 1 and 1/4 inches long, 1/4 inches wide, 1/8 inch thick, made of Zytel 101, and accommodates two parallel pairs of WF16( )/(U) type cable.

Completed Splice

The two parallel pairs of WF16( )/(U) cable are crimped to the splice body in one operation of the crimp tool. The strands are compressed within the inner metal ferrules and the wire insulation is retained with water sealing accomplished by crimping the outer metal sleeves. The completed wire splice is mechanically and electrically sound as well as water resistant.

SUMMARY

The following summarizes the testing performed, prior to the submission of one tool and 400 splices to the Signal Corps, Fort Monmouth, New Jersey, in accordance with Contract Number DA36-039 SC87226. A prototype tool and splices, duplicating the items submitted, were put through a series of tests and observations to determine their ability to comply with SCL4272. Wherever testing deviated from SCL4272, an explanation is provided and can be found in the Test Procedure Section of this report.

Summarizing: The tensile strength of the crimped splice was found to be between 65 pounds and 85 pounds with an average tensile strength of 75 pounds. The dielectric strengths of the joint were well above requirement, from 1700 V to 3000 V AC, when checked in a salt bath solution for one minute. The insulation resistance, dry, of crimped splices was infinite and the resistance of the same splices, measured under water, was found to be between 1,000,000 and 3,500,000 ohms. In general, the tool functioned well, being able to perform all operations of wire stripping and splice crimping satisfactorily, with a reasonable speed, as well as under extreme temperature

conditions. All specific performance data, test results, and pertinent explanations can be found in the body of this report.

REFERENCE SPECIFICATIONS

Technical requirements of Splice and Splicing Tool for Cable, Telephone, WF-16( )/(U)	SCL4272
Salt Spray Test	MIL-STD-202B, MIL-STD-101A, Cond. B
Insulation Resistance	MIL-STD-202B, Method 302 Cond. A Para. 4.6.12 of MIL-C-26482
Dielectric Strength	MIL-STD-202B, Method 301 Para. 4.6.11 of MIL-C-26482
Temperature Test	MIL-STD-169

TEST EQUIPMENT

Item	Manufacturer
Resistance Tester	Freed Transformer Company Model 1620, 2,000,000 Megohms 0-1000 volts.
Cold Temperature Chamber	American Instrument Company No. 4-335P, Serial 8704
Oven	Labline, Incorporated Model 3605, Serial 258
Salt Spray Chamber	Industrial Filter and Pump Company Type C.A.
Tensile Testing Machine	Tinius Olsen Testing Machine Company Serial No. 39797 2,000 pounds maximum
Dielectric Test Set	Industrial Instrument Company Model P3A, Serial 503 0-7000 volts A.C.

TEST PROCEDURE

Certain tests were not performed because of lack of equipment, or because of insufficient definition of test. This applies to the vibration test, the bounce test, the rain test, and the dust test.

Certain other tests were not performed because of limitation of time. This applies to the humidity and salt spray test. However, the basic tool, catalog number MR8, has passed the salt spray tests previously (Ref. First Quarterly Report 15 September 1961).

1. Tensile Test.

   Test samples were made with a splice joining cable leads of 24 inch lengths, and identified by number for reference purposes. The leads were wrapped around two one inch knurled mandrels, with the wire ends fastened by means of a special holding clamp. These gripping fixtures were then placed into the jaws of a Tinius Olsen Testing Machine, in such a manner that the splice was held approximately 8 inches, equidistant, from the upper and lower jaws. All samples were pulled at a rate of one inch per minute.

2. Dielectric Test.

Dielectric test samples were prepared in the following way: complete crimped splices were made. The conductor was cut off at one end of the splice and this end was sealed. The splice was then immersed in a salt solution to a depth of approximately 1/16 inch less than its entire length. The test potential was applied between the two conductors of the WF-16( )/(U) telephone cable through the crimped splice. This procedure complies with MIL-STD-202A, Method 301. The applied potential ranged from 1500 to 3000 volts, rms., at 60 cps, for one minute.

3. Insulation Resistance Test.

The insulation resistance measurements were taken between the two mutually insulated inner ferrules, after crimping, following a soak in one foot of water for 24 hours. The readings were taken after a two minute period of electrification (100 volts plus or minus 10%). Readings were also taken and recorded between the two insulated ferrules and water ground, per the above procedure, in accordance with MIL-STD-202, Method 302, Condition A.

4. Temperature Test.

The crimping tool (MR8-77) was subjected to the temperature extremes per MIL-STD-169 as follows: The tool was placed in an oven for approximately six hours and brought to thermal equilibrium at 160°F and functionally tested. Immediately upon removal of the tool from the oven, four complete splices were made. The tool was then subjected to a temperature of -65°F for approximately six hours after which it was again functionally tested. Four complete splices were made with the tool immediately upon its removal from the cold chamber. The tool was operated with insulated mittens.

TEST DATA

1. Tensile Test

No. Samples Tested	24
Tensile Strength Range:	
Minimum	65#
Maximum	85#
Average Tensile Strength	75#

2. Dielectric Test

No. Samples Tested	20
Dielectric Range:	
Minimum	1,700 v
Maximum	3,000 v
Average Dielectric Strength	2,500 v

3. Insulation Resistance Test

No. Samples Tested	14
Resistance Range:	
Minimum	1,000,000 ohms
Maximum	3,500,000 ohms
Average Insulation Resistance	2,500,000 ohms

4. <u>Temperature Test</u>.

Temperature Range:

160°F
-65°F

<u>Results</u>: At both temperature extremes the wire strip mechanism was actuated and determined to be operational. Wire was inserted into mechanism, stripped and compared to that prepared at room temperature; the comparison showed no variation or damage due to the temperature variation. Crimps were also made at these extreme temperatures to insure that the tool mechanism, crimp die, ratchet, etc., functioned properly. The results of this test was satisfactory and indicate that joint tensile strength is obtainable with the tool at these temperatures. (NOTE: The tension values fell within the 65 pounds to 85 pounds range established at room temperature.)

SUMMARY OF TEST RESULTS

1. Tensile Test.

The specified tensile requirement was previously established at 85% of 85 pounds (the minimum tensile strength of the WF16( )/(U)cable). A statistical analysis of our test data indicated that a range of values from 65 pounds to 85 pounds may be expected in 96% of all crimps made with the tool and splice being submitted. Further evaluation of the tensile data shows an expected average tensile value of 75 pounds. During the testing program it became apparent that the tensile test was very critical with regards to proper wire location in the splice as well as proper alignment of the tensile fixtures in the tensile testing machine. Due to the high strength and low elongation (.8%) of WF16( )/(U) cable, any irregularities in the method of tensile testing the crimp samples would result in abnormal (low) tensile values. This is primarily due to the fact that slack may be present in one wire of the parallel pair being tested with early rupture resulting in the tight wire leading to

premature rupture of the splice joint. Where both wire ends of the splice were equally loaded, the 75 pounds average tensile value was obtainable. It is our contention that a per-centage of the lower values (65 pounds/68 pounds)resulted from lack of care in preparing the tensile samples as well as improper tensile testing of the complete splice (Reference: Appendix - Monthly Report 15 June 1962).

2. Dielectric Test.

All indications are favorable with regard to meeting the requirements of MIL-STD-202A, Method 301. No failures were incurred throughout the test program and it is reasonable to expect complete compliance with MIL-STD-202A, Method 301.

3. Insulation Resistance Tests.

The test data indicates that with the present submission of one tool and 400 splices, we will not be able to realize the specification requirement of 10,000,000 ohms in wet condition. The observed ranges in from 1,000,000 to 3,500,000 ohms. The resistance, when measured dry, was found to be infinite but dropped to the above

mentioned range after soaking in one foot of water for 24 hours. We were able to establish the leakage path, reason for the path and the indicated corrective action which we are prepared to take. Leakage leading to the reduced resistance readings was occurring through the ends of the test splices, indicating a need for more compression on the cable insulation and/or more insulating material in the sealing area under compression. Preliminary evaluations have indicated that by increasing the thickness of the insulating nylon under the sealing crimp, values giving a range of higher magnitude than those recorded with the present tool and splice will be attainable. (Reference: Monthly Report, 15 June 1962.)

APPENDIX I

INSTRUCTIONS FOR USING MR8-77 HYTOOL

INSTRUCTIONS FOR USING MR8-77 HYTOOL

Instructions for the proper preparation of the conductor and making of the splice for WF16 ( ) / (U) telephone cable are described on the following pages. For best results and ease of assembly these steps should be followed in the sequence shown. Both conductors to be spliced should be prepared before a splice is placed in the tool.

A. Wire Stripping

1. With ratchet fully released, insert cable into stripping mechanism through cable guide hole (see Figure 1) and push wire until it is exposed at other end of hole, or place finger over other end of hole and push wire in until contact with finger is felt.

2. Actuate tool by closing handles to full butt position and hold. Lace wire through fingers (or wrap around hand) so that back of hand can be seated against face of tool; with cable tightly gripped, pull wire out of stripping mechanism by rotating hand away from tool face such that (see Figure 1) tool face acts as a pivot point.

3. Holding tool in a vertical position release the handles and rotate the tool back to a horizontal position. This action will allow the small piece of stripped insulation to fall free of the stripper mechanism.

4. Press stripped cable into wire holder on back side of tool so that approximately 8 inches of cable overhangs (see Figure 1).

5. Repeat steps 1, 2 and 3 above to prepare second piece and secure it to tool face wire holder.

B. <u>Making of Splice Crimp</u>

1. With ratchet fully released, retract slide to loading detent position (see Figure 1).

2. Place splice into slide and depress into position. (Ref: Figure 1).

3. Move slide into tool until it stops against lower die.

4. Close tool handles until slight pressure is exerted on splice (first tooth of ratchet mechanism will be engaged at this point) and hold (NOTE: DO NOT BUTT THE TOOL.)

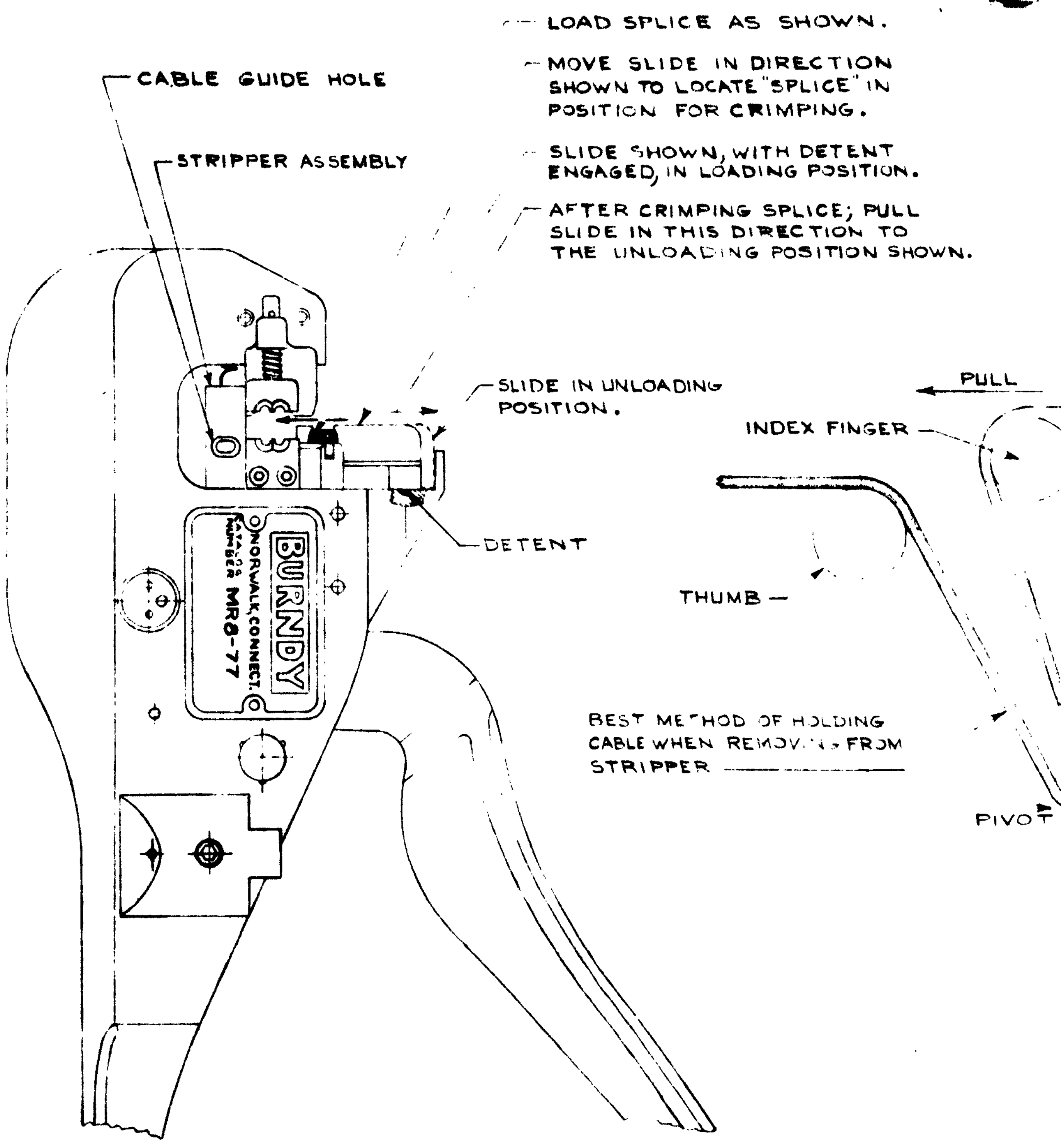
5. With free hand, insert pre-stripped cables into splice being careful to fully insert the cable so that

all wire strands are properly located in the metal ferrules.

6. Close tool handles to full butt position and release. (NOTE: Ratchet must release to allow handles to open.)

7. Retract slide until it meets stop and remove crimped splice (Ref: Figure 1).

1



SIDE VIEW
DIE IN OPEN POSITION

C

SPLICE AS SHOWN.

SLIDE IN DIRECTION
TO LOCATE SPLICE IN
N FOR CRIMPING.

SHOWN, WITH DETENT
ED, IN LOADING POSITION.

CRIMPING SPLICE; PULL
IN THIS DIRECTION TO
NLOADING POSITION SHOWN.

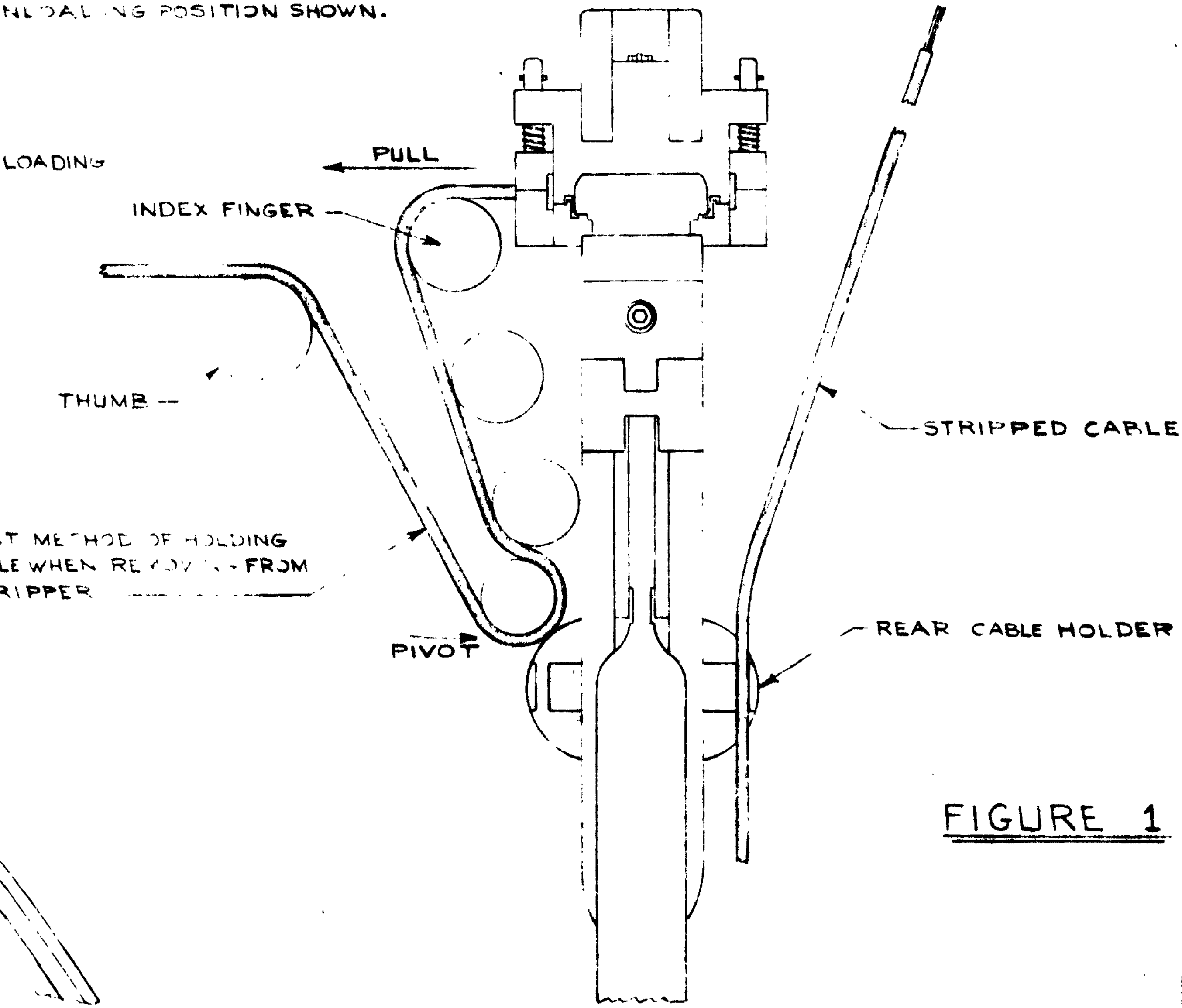


FIGURE 1

END VIEW
DIE IN CLOSED POSITION

SKM 12866-

B

SHEET 2 OF 2

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